Use Log-Likelihood Instead of Fixed Effect Significance

- Statisticians call log-likelihood the "Gold Standard" for fitting a model
- A mixed model uses a random effect and a fixed effect
  - the random effect measures whether the responses differ from vehicle to vehicle
  - the fixed effect measures the average response across the fleet
  - log-likelihood improvement measures the combined significance of both effects

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Use Log-Likelihood

- For most cases the log-likelihood improvement criteria and fixed effect significance lead to the same model
- Differences occur when the log-likelihood improvement is highly significant but the fixed effect is not fully significant (i.e. <95%)
  - This means random effect extremely important
  - Eliminating a parameter at such a point implies that the vehicle to vehicle variance will be confounded into other parameters

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Use Log-Likelihood

- Example is fuel oxygen for emitters > 410mg
- Log-likelihood improvement significant but fixed effect may often be less than 95% significant
- Data specific to oxygen in such vehicles shows strong effect
  - data from EPA_ATL1 missing due to 4.0 cut off with 2.7 oxygen cap
  - EPA_ATL1 used 4.1 fuel and cap is now 3.5

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Use Log-Likelihood

- Gives more correct representation of the data
- If random effect is significant, then effect varies from vehicle to vehicle and model would be wrong if it assumes the effect was constant.
- Also without this parameter the model will attempt to fit this variance with some other parameter

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Use Log-Likelihood

- If fixed effect is not significant but overall effect is significant, then have wide and significant variation from vehicle to vehicle but the average impact might be zero.
- However, the best estimate of an average effect is generally not zero.
- Assuming zero is forcing the model to arbitrarily assume an average of zero rather than the best estimate

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Fix Database

- EPA_ATL1 fuel H (4.1% oxygen) should be added
  - raising cap from 2.7 to 3.5 implies 5.2 upper limit to database
  - methanol data at 5.3% oxygen but RVP of this data is near 12 psi
  - Federal Register (59 FR 36944) shows that 10 volume ethanol (nominal 3.5 wt) can be legal to 4.0% oxygen

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Fix Database

- Duplicates exist in EPA_ATL1 data
  - Six vehicles used in ATL2 involved
  - Fuels involved are C, D, E, F, G, and H
- Also note single tests used in EPA study, but multiple tests used in other studies
  - SAS Mixed Model weights by number of tests
  - While certainly "better" are they twice or more?
  - Could use fuel/vehicle averages as bracket model
  - Auto/Oil used averages to study fuel effects

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Reasons to include >410 mg effects

- Engineering
  - High mileage with poor catalyst efficiency that fuel oxygen might improve
  - Any open loop operation that fuel oxygen is known to improve
  - Rich fuel/air mixtures that fuel oxygen may mitigate

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Reasons to include >410 mg effects

- Scientific
  - To be more consistent with data such as the EPA_ATL study which directly addressed the comparison of fuel oxygen between low and higher emitting vehicles
  - Higher emitter effects noted as important by recent NAS panel on ethanol in RFG

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Reasons to include >410 mg effects

- Environmental
  - higher emitter fraction increases with age
  - database will have more higher emitters in 2005

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